Insect-based meat alternatives: The role of information and social influences on the beliefs about sensory properties, attitudes and intention to consume insect-based products

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Abstract

The rise in the human population means that the demand for meat will soon be so high that it will impose severe burdens on the environment. Alternatives such as insect-based products are needed for food provision and to protect the environment. Insect-based food products are not regularly consumed by westerners, owing to a lack of knowledge about the existence of such products and the environmental impact of meat production. Food neophobia, which is a reluctance to eat new foods, a lack of familiarity and perceived lower sensory properties as well as a lack of exposure to insect-based products are further reasons for the unpopularity. The theory of reasoned action states that people's beliefs influence their attitudes, and attitudes together with social norms influence their behavioural intentions. This theory provides the conceptual framework of the current study. The aim was to investigate whether information about sensory properties, and social influence – or an interaction between these two variables – could successfully change participants' beliefs and attitudes about insect-based products. If these factors affected the participants' intention to consume or not consume the products were also examined. The study used informative material to influence the beliefs and attitudes of the participants. The social norm aspect was addressed through the use of social media, namely Facebook posts about insect-based products. A 2x2 between-subjects research design was applied in an online experiment. Beliefs about the taste, look and texture of insect-based products, and people's attitude toward these products and intention to consume them, were measured afterwards. The results showed that information about sensory properties had a significant effect on beliefs about the look of insect-based products. Providing information about the sensory properties of insect-based products seems to be a promising approach to change the beliefs that many people hold about the look of these products. An unfavourable Facebook post about insect-based products was also shown to have a significant effect on the intention to consume insect-based products. However, trying to persuade people through social influence can have opposite consequences to what was intended. Unfavourable social influences could evoke curiosity or reactance, which in turn might facilitate a change in beliefs, attitudes and intentions with regard to consuming these products. Other effects were not significant. An explanation for the findings might be that merely providing information is insufficient to change attitudes. Real-life exposure to insect-based products might be a more suited approach to successfully change the beliefs, attitudes and intentions of potential consumers.

Keywords: Theory of reasoned action, entomophagy, meat substitutes, sensory properties

Samenvatting

Door de toekomstige groei in de populatie zal de vraag naar vlees tot een niveau stijgen dat uiterst negatieve gevolgen zal hebben voor het milieu. Alternatieven, zoals op insecten gebaseerd voedsel, zijn nodig om de populatie te voeden en het milieu te beschermen. Er worden echter geen insecten gegeten in de westerse populatie. Dit komt ten eerste door een gebrek aan kennis over het bestaan van insectenproducten en de gevolgen van vleesproductie voor het milieu. Ten tweede heerst in het Westen voedsel neophobia, een gebrek aan vertrouwdheid en waargenomen lager sensorische eigenschappen van deze producten. Verder is ook een gebrek aan blootstelling aan deze op insecten gebaseerde producten een reden dat deze niet populair zijn. De "theory of reasoned action" is het theoretische kader van deze studie. De theorie toont aan dat opvattingen de attitude beïnvloeden, die vervolgens samen met de sociale norm de gedragsintentie beïnvloedt. Het doel van de studie was om te onderzoeken of informatie over sensorische eigenschappen en de sociale invloeden succesvol zijn in het veranderen van de opvattingen en attitude over insectproducten en in het veranderen van de intentie om deze producten te consumeren. Informatiemateriaal werd gebruikt om de opvattingen en attitude van participanten te beïnvloeden. De sociale norm werd gemanipuleerd door het gebruik van sociale media, namelijk Facebook posts over insectenproducten. Een 2 (neutrale informatie versus informatie inclusief data over sensorische eigenschappen) x 2 (positieve Facebook post versus negatieve Facebook post) between-subjects design werd toegepast op een online experiment. Opvattingen over smaak, uiterlijk en structuur van insectproducten, de attitude met betrekking tot deze producten en de intentie om ze te consumeren werd gemeten na de manipulatie. Er was een significant effect van de informatie over sensorische eigenschappen op de opvatting over het uiterlijk van insectproducten. Het ter beschikking stellen van informatie over sensorische eigenschappen lijkt een veelbelovende aanpak te zijn om de opvattingen, attitude en gedragsintentie met betrekking tot insecten te veranderen. Daarnaast was er een significant effect van de negatieve Facebook posts op de intentie om insectproducten te consumeren. Het overtuigen van mensen via sociale invloeden lijkt tot een omgekeerd effect te leiden. Negatieve sociale invloeden zouden dus gebruikt kunnen worden om nieuwsgierigheid of reactantie op te wekken. Deze kunnen een verandering van opvattingen, attitudes en gedragsintenties met betrekking tot insectproducten bevorderen. Alle andere effecten waren niet significant. Een verklaring hiervoor kan zijn, dat informatie alleen niet voldoende is, maar dat blootstelling aan insectproducten nodig is om op een succesvolle manier de opvattingen, attitudes en intenties van mensen te veranderen.

Introduction

The world's population is expected rise to an estimated 9 billion people by 2050 (Food Agriculture Organization (FAO), 2009). As a result, the demand for food will be 70% higher if the global population is to access sufficient amounts of food (FAO, 2009). According to the FAO (2006, p. xx), the increase in population will lead to an upsurge of more than 100% in global meat production, "from 229 million tonnes in 1999/01 to 465 million tonnes in 2050". This increase will have massive consequences for the environment. Currently the livestock sector already accounts for 18% of global greenhouse gas emissions and 8% of the global human water use, and has a major impact on biodiversity (FAO, 2006). In addition to the negative consequences for the environment, meat production is inefficient, because livestock consume more protein (77 million tonnes) than meat provides for human nutrition (58 million tonnes) (FAO, 2006).

Because meat production already imposes global challenges, alternative products are needed to ensure the nourishment of all humans and to protect the planet from the environmental consequences of excessive meat production. One alternative is provided by plant-based meat substitutes such as soy or tofu products (Hartmann & Siegrist, 2017). Another possibility is the use of stem cell technology to culture in-vitro meat (Bhat & Fayaz, 2011). A third option is insects, which offer a promising substitute for meat because they provide a comparable amount of protein while being easier to breed sustainably (FAO, 2013). Approximately 1700 species of insects are eaten in roughly 130 countries, mainly in the form of larvae or pupae (FAO, 2010). The most frequently consumed species are coleoptera (beetles), hymenoptera (ants, bees and wasps), orthoptera (grasshoppers, cockroaches and crickets) and lepidoptera (butterflies and moths) (FAO, 2010).

Insects are not consumed by most westerners (Hartmann & Siegrist, 2017) and diverse reasons for this lack have been identified. People generally underestimate the impact of meat consumption on the environment and their personal ecological footprint (Vanhonacker et al., 2013; Hartmann & Siegrist, 2017). However, knowledge about the environmental impact of meat consumption has been shown to provide insufficient motivation to switch to a sustainable diet (Hartmann & Siegrist, 2017). Several studies have demonstrated that people are unwilling to change their meat-eating behaviour (Hartmann & Siegrist, 2017). The resistance to consuming meat substitutes in general might result from an existing "negative image" about the alternatives (Vanhonacker et al, 2013). The substitutes are often not seen as adequate alternatives to meat because of "perceived lower quality and sensory properties" (Vanhonacker et al., 2013). Entomophagy, the use of insects as food for humans, remains

unpopular among people in the western world for several additional reasons (Megido, Sablon, Geuens, Brostaux, Alabi, Blecker, Drugmand, Haubruge & Francis, 2013). On the one hand, the idea of eating insects can evoke neophobia. On the other hand, the lack of popularity, information and exposure, as well as the perceived sensory properties of insect-based products, are further reasons insects are not eaten in the West (Megido et al., 2013). Tan, Verbaan and Stieger (2017) indicate that unknown food is better accepted if the product's quality is high with regard to the consumer's sensory experience, and if people are familiar with the look of the product and manner of preparation. Thus, the main factors for instilling acceptance of insects as a food source are "sensory properties", "exposure and increasing familiarity" and "positive experiences" (Hartmann & Siegrist, 2017, p. 23). Research has also shown that men and women might differ in their beliefs, attitudes and intentions towards insect-based products (Verbeke, 2015).

According to the theory of reasoned action, two main factors influence the behavioural intentions of a person: attitude and the subjective norm (Ajzen, 2012). Subjective norm is the felt social pressure to execute a certain behaviour (Ajzen, 2012). Attitude is in turn influenced by the person's beliefs about behaviour. Thus, the intention to consume insect-based products is affected by positive beliefs about insects as a food choice through the promotion of a positive attitude about insects as food choice as well as social influence that encourages the consumption of these. The theory also emphasizes that attitudes and subjective norms work together to affect intention. That is, both components acting together may have a greater influence on behavioural intention (Ajzen, 2012). The influence of attitude and subjective norms on the intention to eat novel foods, such as insect-based products, has been confirmed by experimental studies (Menozzi, 2017).

To date, few studies have examined whether a positive attitude towards insect-based products can be promoted by providing information about meat alternatives, in line with the above-mentioned factors of positive attitude. The sensory properties of meat alternatives are of special interest. Subjective norms, as an influencing factor, have also been neglected by most studies. Social media are known to be an important tool for influencing the subjective norms of individuals (Goldsmith & Goldsmith, 2011). This effect is explained by Cialdini's "social proof" principle (Cialdini, 2001). According to Cialdini (2001, p. 75), "human beings rely heavily on the people around them for cues on how to think, feel, and act." Several studies have investigated the influence of online social proof, and have concluded that the valence of comments, reviews and other material plays an important role in the formation of subjective norms (Vermeulen & Seegers, 2009; Winter et al., 2015). Facebook is among the

most popular social media channels and is used as a source of information and when forming an opinion about important topics. Therefore, it is a suitable platform to influence people to change subjective norms, by showing them positive comments from other people about insect-based products (Cheung et al., 2011).

Current study

The aim of this research was to explore whether information about insect-based products, designed to address the factors of a positive attitude, could successfully change people's attitudes toward insects as a food choice. The information given to participants comprised the important determinants for a positive attitude toward these products, namely sensory properties (taste, look and texture). Additionally, the question of whether the valence of online social proof would influence people's subjective norms with regard to consuming insect-based products was assessed. Because attitude and subjective norms together exert a stronger effect on behavioural intention, a possible interaction effect was examined with regard to the intention to consume insect-based products.

The sample was randomly divided into four groups, which received different experimental stimuli (described in the Design section below). Briefly, the conditions were as follows: informative text containing either neutral information or additional information about the sensory properties (taste, look and texture), combined with a Facebook post with either positive or negative comments.

Hypotheses

It is hypothesized, that

(1) The presentation of information exerts a main effect. Information that emphasizes the sensory properties of insect-based products will lead to more positive beliefs about the taste, look and texture of insect-based products, relative to neutral information. A positive attitude and stronger behavioural intention to consume insect-based products are also expected.

(2) The valence of Facebook comments exerts a main effect. Positive comments will lead to more positive beliefs about the taste, look and texture of insect-based products, relative to negative information. A positive attitude and stronger behavioural intention to consume insect-based products are also expected.

(3) The valence of comments and the presentation of information combine to create an interaction effect. Positive comments and information that emphasizes the sensory properties of insect-based products will lead to more positive beliefs about the taste, look and texture of insect-based products. A more positive attitude and

stronger behavioural intention to consume insect-based products are also expected, compared with the effect of only one of these two factors.

Methods

Participants

A convenience sample of 214 persons (33.2% male, 66.8% female) was recruited through the Sona system of the University of Twente and through Facebook. Participants who signed up through the Sona system received 0.25 Sona points, whereas Facebook participants received no reward. Participants were included in the experiment only if they fulfilled the criteria of being 18 years or older and being able to speak English sufficiently well (European B2 level). Approval for the study was obtained from the ethics commission of the University of Twente. Seventeen participants were excluded because they did not answer a manipulation check question about the valence of Facebook comments correctly (6 people perceived the positive Facebook post as neutral or negative, and 11 people perceived the negative Facebook post as neutral or positive). Twenty participants were excluded because they stated that they did not find the article trustworthy. No differences were found between the remaining sample and the excluded cases with regard to sociodemographic data and the results of the inferential statistical analyses. Among the final 177 participants (31.1% male, 68.9% female), the mean age was 23.41 years (SD = 6.13). Most participants were German (76.3%), a sizeable minority were Dutch (16.4%), and a few stated they had other nationalities (7.3%). The majority were university students (84.7%). A check for randomization showed that the groups did not differ significantly in sex, age, nationality, education and occupation. Appendix A shows the statistical results of the randomization check.

Design

A 2x2 between-subjects design was used. The two experimental variables were presentation of information and valence of comments. Participants were randomly assigned to one of the following four conditions: (1) neutral text information + positive Facebook post (N=47); (2) neutral text information + negative Facebook post (N=46); (3) neutral text information with additional information about sensory properties + positive Facebook post (N=42); and (4) neutral text information with additional information about sensory properties + negative Facebook post (N=42). Figure 1 illustrates the 2x2 design.

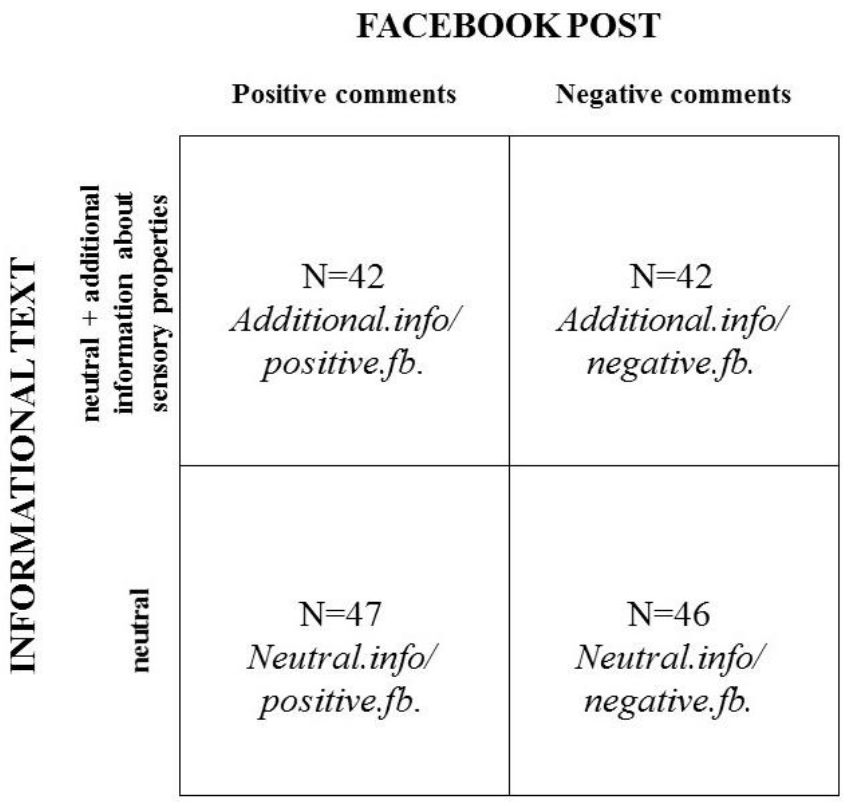

Figure 1. 2x2 between-subjects design of the current study. The four conditions are: 1) neutral informational text with additional information + positive Facebook post, 2) neutral informational text with additional information + negative Facebook post, 3) neutral informational text + positive Facebook post, and 4) neutral informational text + negative Facebook post

All participants received text information in the form of an article. In the neutral condition, the article began by presenting information about why alternatives to meat are needed: higher demand for food in the future and the negative impact of meat production on the environment. Insects were then presented as an alternative that is eaten in many cultures; insect products are high in protein, sustainable, healthy and safe to consume. Examples of edible insects were given. The text in the other conditions was identical but presented additional information. It stated that the consumption of pure insects is not necessary and that insect-based products are available, which are tasty and do not look like insects. Examples were given (schnitzel, burger, nuggets, granola, muesli bars and flour). The products were described as delicious, tasty-looking, healthy and good for the environment. At the end of the articles, a picture of a pasta dish filled with insect-based products was included (Appendix B).

Participants in both conditions received a Facebook post with the question "What do you think about insect-based alternatives?" followed by three pre-written comments. In the

positive condition, these three comments were positive statements about the taste, the look and the texture of insect-based products. In the negative condition, the comments were formulated the same way but with a negative view of the taste, look and texture of insect-based products. Names of the fictional persons who had written the comments, the number of likes, and the time the comments were written were the same for both conditions to make the posts comparable (Appendix C).

Measures

Socio-demographics. Age, sex, nationality, level of education and current occupation were measured to assess the participants' socio-demographic backgrounds.

Beliefs about sensory properties. Three beliefs about insect-based products were measured: taste, look and texture. They were assessed through a single item phrased as follows: "Please choose […], in how far you think you would like or dislike insect-based products based on these attributes." The responses were scored on a 9-point hedonic scale, ranging from 1 for "dislike extremely" to 9 for "like extremely", with 5 representing "neither dislike nor like" (adapted from Guinard et al., 2016). A high score on the item corresponds to a positive belief about the sensory property.

Attitude. To measure people's overall attitude toward insect-based products, four semantic differential items with a 5-point response scale were used. The items contained the responses "bad–good", "unpleasant–pleasant", "unfavourable–favourable" and "negative–positive" ($\alpha = 0.84$ in the current sample) (adapted from Graca, Calheiros & Oliveira, 2015). The first word in each pair was scored as 1 and the last word had a score of 5. A high score on an item implied a positive attitude about insect-based products. The original scale included a fifth item pair, "against–for". This item pair was excluded a priori because it is not suitable for measuring general attitudes toward insect-based products. It rather seemed to reflect an attitude about the launch or production of such products.

Behavioural intention. Three measures, adapted from Hung, Kok and Verbeke (2016) were used to assess the intention to consume insect-based products ($\alpha = 0.88$ in the current sample). Participants were asked 1) if they planned to try insect-based products, 2) if they would probably buy these products, and 3) if they expected to eat them. The responses were scored on a 5-point Likert scale ("totally disagree" to "totally agree"). A high score on the items indicated a strong behavioural intention to consume insect-based products. Appendix D shows a complete list of all the items.

Procedure

After reading and accepting the informed consent forms, participants first filled in a socio-demographic questionnaire. Participants then viewed an online article about insect-based products, which contained either neutral information or had additional information about the sensory properties of insect-based products (Appendix B). Afterwards they were shown a Facebook post about the article, which included either three positive or three negative comments about insect-based products (Appendix C).

Next, the participants answered three sets of questions about the following aspects: 1) their beliefs regarding the taste, look and texture of insect-based products; 2) their evaluation of insect-based products, presented as a choice between five pairs of attributes concerning insect-based products; 3) their behavioural intentions with regard to the consumption of insect-based products (Appendix D). Finally, the participants were debriefed and thanked for their participation, and were given contact details in case they had further questions about the online study.

Data analysis

The program Qualtrics was used to conduct the online experiment. The data were downloaded and later analysed with the program IBM SPSS Statistics 22. Descriptive summaries were computed to record the socio-demographic characteristics of the sample. To assess whether the dependent variables were normally distributed, a Shapiro-Wilk test was computed. Levene's test was used to assess the homogeneity of variance for each group with regard to independent variables. To assess the hypotheses, two-way ANOVA was conducted for each dependent variable (taste, look, texture, attitude and intention). A prerequisite for conducting ANOVA is that the dependent variable must be continuous. The measurement of beliefs about the sensory properties of insect-based products yielded non-continuous data, using single items with 9-point scales. According to Agresti (2010), it is common practice to treat variables that are categorical and ordinal as if they are continuous for the purpose of statistical analysis, as long as the data present many categories. Post-hoc analyses included computing the effect sizes and the statistical power given the sample size. Pairwise comparison of marginal means was also performed, as was moderator analysis to check whether sex was a moderating variable.

Results

Table 1 shows the means, standard deviations and correlations for the dependent variables (constructs). The means for taste, attitude and intention were all approximately at the mid-point of the scales. The means for items regarding the look and texture of insect-based

products were below the mid-point. All constructs showed a positive correlation with each other. The reliability for all scales was acceptable to good (α = 0.84 for the attitude scale; α = 0.88 for the behavioural intentions scale).

Table 1

Summary statistics and correlations for the dependent variables (N=177)

					Correlations				
Construct	Mean	SD	α	λ^2	Taste	Look	Texture	Attitude	Intention
Taste[a]	4.50	2.08	-	-	1				
Look[a]	4.06	2.03	-	-	.48**	1			
Texture[a]	3.85	1.97	-	-	.52**	.57**	1		
Attitude[b]	3.04	0.89	.83	.84	.51**	.37**	.48**	1	
Intention[c]	2.70	1.08	.88	.88	.71**	.38**	.50**	.66**	1

Note. SD = standard deviation; α = Cronbachs' alpha; λ^2 = Lambda 2
** significant at p = .01 (2-tailed)
[a] measured on a 9-point scale, with 1=dislike extremely; 9=like extremely; 5=neutral midpoint
[b]measured on a 5-point semantical scale, with 1=negatively connotated word; 5=positively connotated word
[c]measured on a 5-point Likert-scale, with 1=totally disagree; 5=totally agree

Table 2 shows the means and standard deviations for each construct and in each experimental condition. For each construct, the means were similar across all conditions. Only the mean of "look" was higher in the additional information-article condition than in the neutral-article condition, and this result was unaffected by the valence of the Facebook post. Also, the mean score for the intention to consume insect-based products was higher for the negative Facebook post group, for both the neutral article and the neutral article with additional information.

Table 2

Means and standard deviation for each experimental condition (N=177)

	Neutral Article + additional information						Neutral article					
	positive FB post (N=42)		negative FB post (N=42)		total (N=84)		positive FB post (N=47)		negative FB post (N=46)		total (N=93)	
Construct	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Taste[a]	4.40	1.75	4.69	2.05	4.55	1.90	4.70	2.34	4.22	2.11	4.46	2.23
Look[a]	4.33	2.06	4.69	1.97	4.51	2.01	3.57	2.04	3.72	1.93	3.65	1.98
Texture[a]	3.88	1.97	4.24	1.83	4.06	1.90	3.62	2.15	3.72	1.92	3.67	2.03
Attitude[b]	2.97	0.91	3.08	0.92	3.03	.91	2.96	0.88	3.15	0.89	3.05	.88
Intention[c]	2.55	0.99	2.96	1.04	2.75	1.03	2.51	1.11	2.80	1.13	2.65	1.12

Note. M= mean; SD = standard deviation.
[a] measured on a 9-point scale, with 1=dislike extremely; 9=like extremely; 5=neutral midpoint
[b]measured on a 5-point semantical scale, with 1=negatively connotated word; 5=positively connotated word
[c]measured on a 5-point Likert-scale, with 1=totally disagree; 5=totally agree

To test the normality of the dependent variables, Shapiro-Wilk tests were conducted. The *p*-values were below 0.05 for all variables except attitude (p=.056, additional information-article condition; p=.079, neutral-article condition; p=.128, positive FB condition). However, the normal Q-Q plots showed that the residuals of all variables were normally distributed (Appendix E shows all *p*-values). ANOVA is known to be robust when used with data that are not normally distributed (Khan & Rayner, 2003). A normal distribution of residuals is therefore a sufficient prerequisite to conduct ANOVA, even if the Shapiro-Wilk results are significant. For the independent variables, Levene's test showed that homogeneity of variance occurred for all combinations of the groups (p>.05). Overall, the assumptions underpinning ANOVA were fulfilled by the data.

Hypothesis testing

Two-way independent ANOVA was employed to examine the effect of information type and social influence with regard to each dependent variable (beliefs about taste, look, texture, attitude and intention). Table 3 shows all the F-values and significance levels.

H1. A main effect of information on the belief about the look of insect-based products was found ($F_{(1,173)}$= 8.25, p<.01, η^2 =.05). All other effects of information on the remaining four dependent variables were not significant at the .05 level. The first hypothesis (H1) must be at least partly rejected.

H2. The results showed a main effect of the Facebook comment valence on the intention to consume insect-based products ($F_{(1,173)}$= 4.69, p=.02, η^2 =.03). All other effects of comment valence on the four remaining dependent variables were not significant (p>.05). The second hypothesis (H2) must also be at least partly rejected.

H3. No interaction effect was found between information type and Facebook post (p>.05). The third hypothesis (H3) has to be fully rejected.

Table 3

Results of the Two-Way ANOVA and Proportion of Explained Variance for each Construct

	Article			Facebook post			Interaction		
	F	*p*-Value	η^2	F	*p*-Value	η^2	F	*p*-Value	η^2
Taste	0.08	.39	.00	0.10	.38	.00	1.51	.11	.01
Look	**8.25**	**.003**	**.05**	0.69	.20	.00	0.13	.36	.00
Texture	1.74	.40	.01	0.59	.22	.00	0.19	.33	.00
Attitude	0.04	.42	.00	1.21	.14	.01	0.07	.40	.00
Intention	0.38	.27	.00	**4.69**	**.02**	**.03**	0.15	.35	.00

Note. Significant results are in bold; test is significant with $p < .05$
η^2 = proportion of total variance that is explained by the independent variable

Post-hoc-analyses

For the construct related to beliefs about the look of insect-based products, the η^2 of 0.05 indicates that 5% of the variance was accounted for by the informative article. Using the program G*Power (Faul, Erdfelder, Buchner, & Lang, 2009), a corresponding effect size (f=.23) and the statistical power (.86) were computed. Similarly, 3% of the variance in the construct related to the intention to consume insect-based products was accounted for by the Facebook post, with an effect size f=0.18 and power of 0.64. Both effect sizes are small according to the standards provided by G*Power (f=.10, small; f=.25, medium; f=.40, large) (Faul, Erdfelder, Buchner, & Lang, 2009). It can be concluded that the manipulated variables

accounted for only a small percentage of the variance in the data. The power was high enough to detect small to medium effect sizes.

The ANOVA results show whether a difference exists between groups but it cannot indicate the directionality of an effect. Pairwise comparison of estimated marginal means was computed to assess the direction of effects that were found for look and intention. For the construct related to look, the mean difference between the groups with regard to the article (positive or neutral) was significant (M=.87, SE=.30, p<.05, 95% CI [.27, 1.46]). By contrast, the mean difference between the groups with regard to the positive and negative Facebook post was not significant. Hence, the mean score of belief about the look of insect-based products is higher in the positive article condition in comparison to the neutral article condition. A significant negative mean difference between the conditions "positive Facebook post" and "negative Facebook post" was found (M =-.35, SE =.16, p=.03, 95% CI [-.67, -.03]). Thus, the mean score of the intention to consume insect-based products is higher in the negative Facebook post condition than in the positive Facebook post condition. The difference between the means for groups that were given different article conditions was not significant for the construct "intention".

Verbeke (2015) indicated that women and men might differ in their beliefs, attitudes and intentions towards insect-based products, including the consumption thereof. A moderator analysis was conducted, using sex as the moderating variable, to examine a possible effect of sex on the relationship between the independent and dependent variables. No significant moderating effect was found for any relationships between the independent and dependent variables.

In conclusion, results showed a significant effect of the article on the belief about the look of insect-based products was found. This means that Hypothesis 1 can be accepted, because additional information about sensory properties had a positive effect on people's beliefs about the look of insect-based products. However, Hypothesis 1 must be partly rejected because of the results for the other constructs (taste, texture, attitude and intention).

The valence of the Facebook comments had a significant effect on the intention to consume insect-based products. Hypothesis 2 also has to be rejected partly regarding the constructs of look, taste, texture and attitude. In addition, the explained variance associated with both significant effects was quite low, as were the effect sizes. Further analysis of the estimated marginal means showed that the effect of the Facebook post was the opposite of what had been hypothesized. This means that the negative condition, rather than the positive condition, was associated with a stronger intention to consume insect-based products.

Therefore, Hypothesis 2 has also be fully rejected. Regarding Hypothesis 3, no interaction effect was found, so Hypothesis 3 has to be rejected.

Discussion

Owing to the expected rise in the world's population and therefore also the demand for food, it will be difficult if not impossible to continue the meat consumption patterns of today's society (FAO, 2009; FAO, 2006). Alternatives are needed to alleviate the need for extensive meat production that would lead to negative environmental outcomes. Insect-based products offer such an alternative as they provide a sufficient amount of protein, and insects are easier to breed and impose less of a threat to the environment. Currently, insect-based products are not consumed by the western population for various reasons including a lack of exposure, lack of knowledge and negative opinions about the sensory properties of insect-based products. To gain insight into whether additional information about sensory properties, as well as social influence and the interaction between these two factors can positively affect the beliefs, attitude and behavioural intentions of potential consumers, an online experiment was conducted in this study. The manner of providing information (neutral vs additional information about sensory properties) was manipulated, as was the valence of Facebook posts (positive vs negative).

Additional information about sensory properties had a significant effect on people's beliefs about the look of insect-based products. This finding is in line with previous research indicating that familiarity with insect-based products can lead to more positive beliefs (Megido et al., 2014; Hartmann, Shi, Giusto & Siegrist, 2015). Seeing pictures and receiving extensive information about insect-based products might have led to an increased familiarity with these products.

Additional information about the sensory properties of insect-based products had no significant effect on beliefs about the taste or texture of insect-based products. It also did not affect the attitudes about insect-based products, or the behavioural intention to consume insects. This finding is also in line with previous research, suggesting that influencing people's beliefs about the sensory properties of insect-based products will require giving people exposure to and positive experiences with these products (Megido et al., 2014; Hartmann, Shi, Giusto & Siegrist, 2015). Hence, merely providing information, without people actually experiencing the taste and texture of insect-based products, is insufficient to change their beliefs about the products. According to the theory of reasoned action, these beliefs influence people's attitudes towards insect-based products and the intention to

consume them, which explains why information alone had no significant effect on either variable.

The valence of Facebook posts had no significant effect on people's beliefs about the taste, look or texture of insect-based products. Valence also did not affect people's attitudes towards insect-based products. These findings can again be explained by a lack of exposure to and experience with insect-based products, which previous research has shown is crucial to changing beliefs and attitudes (Megido et al., 2014; Hartmann, Shi, Giusto & Siegrist, 2015). The valence of Facebook comments did have a significant effect on the intention to consume insect-based products. However, in contrast to the researcher's expectation that the positive Facebook post would exert an effect, it was the negative Facebook post that exerted a significant effect on behavioural intention. This effect might be the result of another factor – such as curiosity – playing a role in behavioural intentions. Research suggests that people may seek out negative experiences or actions that have negative consequences, out of curiosity (Hsee & Ruan, 2016). Therefore, curiosity might be the reason why participants indicated a stronger intention to consume insect-based products after reading negative Facebook comments about the products. Participants might have become curious about the factors that led to negative evaluations of the insect-based products.

Another possible explanation for the inverse effect of the Facebook posts might be reactance. When a person feels his or her freedom of choice is threatened by – for example – persuasive tactics, the person might show reactance. This means he or she engages in behaviour contrary to the behaviour that is desired by the persuader (Brehm & Brehm, 1981). In this study, participants might have feel pressured by the strong opinions regarding insect-based products in the Facebook post, and therefore chose a contrary behavioural intention.

There was no significant interaction effect for the information type and the Facebook post with regard to the beliefs or attitude towards insect-based products. There was also no significant interaction effect of these two variables with regard to the intention to consume insect-based products. These findings can be explained by earlier research that indicated that exposure to and positive experience with insect-based products are needed to change beliefs, attitudes and intentions (Megido et al., 2014; Hartmann, Shi, Giusto & Siegrist, 2015). The findings show that information alone is insufficient to change the beliefs, attitudes and intentions of people with regard to insect-based products. Neither is an interaction of additional information about sensory properties and social influence. Thus, providing people with the possibility of a real experience with insect-based products seems necessary if one wishes to apply the theory of reasoned action.

Certain limitations in the current research might have affected the findings. The first is the question of whether the manipulation was successful. Although a manipulation check was conducted regarding the Facebook posts, it is possible that participants speed-read the information and post rather than fully engaging with it. As this possibility is not easily testable, uncertainty about the effectiveness of the manipulation should be kept in mind when interpreting the results. In addition, the informative text differed among the experimental groups. One group received a text which had additional information in it, including a picture. Several studies have shown that the length of a text does not affect the reader's comprehension of the message. Therefore, the effectiveness of the texts should not have been affected by the different lengths of the texts (Jalilehvand, 2012; Mehrpour & Riazi, 2004). In addition, pictures have been shown to facilitate text comprehension (Jalilehvand, 2012; Haring & Fry, 1979). The picture in the second text might have led to better understanding than the text that lacked a picture. The possibility that different formats of the manipulative material might have influenced the participants could not easily be examined, so it has to be taken into consideration when interpreting the results.

Participants' lack of exposure to and experience with insect-based products can be seen as another limitation in this study. Future research should consider combining information and social influence with real-life exposure to insect-based products, by providing a tasting session with the products. Furthermore, the sample in this study had a disproportionate number of women. Research has shown that women and men differ in their intentions to consume insect-based products (Verbeke, 2015). The asymmetrical distribution of sex in this study might have interfered with the detection of any real effect. Although sex did not have a moderating effect with regard to any of the independent variables, future research should ensure a proportional distribution of sex. Furthermore, the scales for measuring beliefs, attitudes and intentions toward insect-based products were adapted from previous studies on research questions. The scales were adapted for the current topic, which means the validity and reliability of the adapted scales are unknown. A validation study could be conducted to assess the scales as an instrument for measuring beliefs, attitude and intentions toward insect-based products.

This study showed that information – including pictures – about the look, taste and texture of insect-based products can influence a person's beliefs about those products, but only with regard to the look of the products. Textual information was not sufficient to change beliefs about taste and texture, or to change people's attitude toward insect-based products or their intention to consume them. Therefore, it is strongly recommended that future studies

should offer participants the opportunity for direct experience with insect-based products. In addition, this study suggested that curiosity might have influenced the intention to consume insect-based products. Especially when encountering negative information or opinions, people might become curious about the topic and more willing to experience the seeming negative consequences themselves. Future research could focus on whether curiosity plays a role in the intention to consume insect-based products.

As the need for meat substitutes will become more pressing in the future, it is important to explore the factors influencing the non-consumption of insect-based products in greater depth. It is also important to provide opportunities for members of society to gain positive experiences with insect-based products. Promoting positive experiences and exposure to insect-based products on a large scale is a promising approach for changing the prevalent beliefs, attitudes and intentions towards insect-based products.

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Appendix

Appendix A

Table A1

Randomization check of all demographic variables through Chi-square/Mann-Whitney-U test

	Article			Facebook post		
	Value	df	*p*- Value	Value	df	*p*-Value
Gender[a]	.001	1	.97**	.05	1	.83**
Age[b]	3700.50		.54**	3847.50		.84**
Nationality[a]	4.25	2	.12**	6.45	2	.04**
Education[a]	2.39	4	.66**	3.40	4	.49**
Occupation[a]	3.91	4	.42**	2.07	4	.72**

Note. df= degrees of freedom; Value: test statistic

**not significant at p = .01 (2-sided)

[a] : Chi-square test

[b]: Mann-Whitney U test

Appendix B

Alternatives to eating meat:
What can and should we eat instead of meat?

Did you know, that the world's population will be approximately 9 billion in 2050 (FAO, 2009)? This huge increase has several consequences that might affect everyone. We will need a lot more food, to ensure the nourishment of the whole population. This cannot work, if we continue to eat the amount of meat we do nowadays. This is, because the production of meat has a huge negative impact on our environment. It accounts for about 18 % of the whole global greenhouse gas emission and 8 % of the global human water use (FAO, 2006). Thus, we will soon need alternatives. And there are already a number of alternative products on the market, and there is one alternative, we would like to introduce to you:

Insects

In other cultures, eating insects is quite normal. They are a good alternative to meat, because they are rich in protein and the process of producing products based on insects is better for the environment than the production of meat. There are a lot of different insects that can be eaten. To get an overview, we will present you, some of the more important ones, as listed by the FAO (2013): Caterpillars, palm weevil, termites, stink bugs and grasshoppers. All of them are safe to consume and considered a healthy, protein rich and sustainable food.

Figure B1. Neutral information article as shown in the online experiment in two of the four conditions.

Alternatives to eating meat:
What can and should we eat instead of meat?

Did you know, that the world's population will be approximately 9 billion in 2050 (FAO, 2009)? This huge increase has several consequences that might affect everyone. We will need a lot more food, to ensure the nourishment of the whole population. This cannot work, if we continue to eat the amount of meat we do nowadays. This is, because the production of meat has a huge negative impact on our environment. It accounts for about 18 % of the whole global greenhouse gas emission and 8 % of the global human water use (FAO, 2006). Thus, we will soon need alternatives. And there are already a number of alternative products on the market, and there is one alternative, we would like to introduce to you:

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But don't worry, you do not have to eat whole grasshoppers or mealworms. There are already some companies that produce tasty products, that do not look like insects and where you do not have the feeling you are currently eating insects. For example, the brand "insecta" created schnitzel, nuggets or burger that are based on insects, but look exactly like the original products and, in addition, taste deliciously. Moreover, you can also buy insect-based granola, muesli bars and even flour. Thus, nowadays you can eat delicious, tasty-looking products, that are based on insects and therefore good for your health and good for the environment.

Figure B2. Information article enriched with information about sensory properties as shown in the online experiment in two of the four conditions. The red rectangle shows the information that differs from the other article.

Appendix C

Figure C1. Negative Facebook Post about meat substitutes with negative comments as shown in the online experiment in two of the four conditions. The red rectangles show the words that differs from the other Facebook Post in valence.

Figure C2. Positive Facebook Post about meat substitutes with positive comments as shown in the online experiment in two of the four conditions. The red rectangles show the words that differs from the other Facebook Post in valence.

Appendix D

Table D1

Items and their Scale-Ranges used per measured Construct

Construct	Nr of items	Scale range	Description items
Taste	1	1 (dislike extremely) – 9 (like extremely)	Please choose on a 9-point scale, in how far you think you would like or dislike insect-based products based on these attributes.
Look	1	1 (dislike extremely) – 9 (like extremely)	Please choose on a 9-point scale, in how far you think you would like or dislike insect-based products based on these attributes.
Texture	1	1 (dislike extremely) – 9 (like extremely)	Please choose on a 9-point scale, in how far you think you would like or dislike insect-based products based on these attributes.
Attitude	4	5-point differential scale	Please indicate for each set of words which word best describes your thoughts about insect-based products: Bad – Good; Unpleasant – Pleasant; Unfavourable – Favourable; Negative - Positive
Behavioural Intention	3	1 (totally disagree) – 5 (totally agree)	Please state on a scale from 1 (= totally disagree) to 5 (= totally agree) in how far you agree with the shown statements: I am willing to consume insect-based products; I plan to consume insect-based products; I will try to consume insect-based products

Appendix E

Table E1

Shapiro-Wilk Test Results for Normality

	Article						Facebook Post					
	Neutral + additional information			Neutral			Positive			Negative		
	Statistic	df	*p*-Value	Statistic	df	*p*-Value	Statistic	df	*p*-Value	Statistic	df	*p*-Value
Look	.94	84	.001	.93	93	.000	.94	89	.001	.94	88	.000
Taste	.95	84	.001	.93	93	.000	.93	89	.000	.95	88	.001
Texture	.95	84	.002	.93	93	.000	.93	89	.000.	.94	88	.001
Attitude	**.97**	**84**	**.056**	**.976**	**93**	**.079**	**.978**	**89**	**.128**	.970	88	.037
Intention	.95	84	.001	.935	93	.000	.934	89	.000	.942	88	.001

Note. df = degrees of freedom; significant results in bold; test is significant at $p < .05$